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Chronoamperometric estimation of cognac and brandy antioxidant capacity using MWNT modified glassy carbon electrode

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ABSTRACT

Cognac and brandy components are electrochemically oxidized on multi-walled carbon nanotube modified glassy carbon electrode at 0.44 and 0.59 V in 0.1 M phosphate buffer solution pH 3.0. Voltammetric behavior of the main antioxidant constituents of cognac (ellagic and gallic acids, syringaldehyde, coniferaldehyde, vanillin, 5-hydroxymethylfurfural and furfural) has been investigated. The peak at the less positive potential of cognacs is caused by oxidation of gallic acid as well as syringaldehyde- and coniferaldehyde. The second peak corresponds to ellagic acid oxidation. One-step chronoamperometry at 0.59 V for 75 s has been applied for the cognac and brandy antioxidant capacity (AOC) evaluation. Ellagic acid, being the main antioxidant of cognac, has been used as a reference substance. The chronoamperometric response of ellagic acid is linear in the range of 0.66–52.8 μM with the limit of detection and quantification at 0.19 and 0.63 μM, respectively. AOC in ellagic acid equivalents per 100 mL of cognac and brandy for different denominations (11 cognacs and 11 ordinary and vintage brandies) has been estimated. AOC of cognacs and brandies increases with the age of the beverages. Positive correlations (r=0.9134–0.9703) with common parameters characterizing antioxidant properties of beverages, in particular antiradical activity, total phenolics content, total antioxidant capacity and ferric reducing power have been observed.

1. Introduction

Aged distilled beverages (cognac, armagnac and other aged brandies) are part of human diet and widely consumed all over the world. Epidemiological studies confirm that moderate consumption of alcoholic beverages has a positive influence on coronary heart disease improving metabolism of lipids, increasing anticoagulant and antioxidant activity and decreasing mortality from coronary disease, as well as from colorectal cancer [1–3].

Aged distilled beverages are rich in phenolic compounds due to their maturation in wooden barrels [4–6]. Phenolic compounds exhibit wide range of biological activity including the antioxidant effect [7]. The antioxidant activity of phenolic compounds depends on their chemical structure, nature of matrix, concentration and oxidation status. In the case of aged distilled beverages, the latter two factors are determined by the aging conditions including the wooden barrel characteristics such as wood botanical species [8–11], toasting level [8,12], barrel size [13] and the cellar environment [8,14]. Therefore, antioxidant properties are used as parameters characterizing the technological aspects of aged distilled beverages production as well as properties of final product [5,15,16].

Various approaches have been described for the evaluation of antioxidant properties of aged distilled beverages using spectrophotometric measurements [17–19]. From the other side, antioxidant effect of phenolic compounds from aged distilled beverages is associated with electron transfer that allows one to use methods of electroanalysis for its evaluation. First of all, antioxidant activity of aged distilled beverages has been studied using electrochemical properties of radical species that are usually used in spectrophotometric assays. Sherry brandies (Solera, Solera Reserva and Solera Gran Reserva) antioxidant activity has been estimated by amperometric reduction of 2,2-diphenyl-1-picrylhydrazyl (DPPH) [20] as well as antioxidant activity of several other commercial aged distillates (Cognacs, Armagnacs and Spanish, French and South African brandies) based on the electrochemical oxidation of 2,2″-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) [21].

An approach based on decrease of polarographic hydrogen peroxide anodic oxidation current has been applied for the determination of antioxidant activity of strong alcoholic beverages such as plum and wine brandies, whiskeys, bitters and sweet fruit liqueurs. Changes of antioxidant activity of some herbal liqueurs during storage under different conditions as well as a quarter century long aging of plum brandy in an oak barrel have been monitored [22].

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